

## AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

### Listing of Claims:

- 1        1. (Previously Presented) A method of flow controlling InfiniBand
- 2        receive traffic, comprising:
  - 3            maintaining a single memory structure for queuing InfiniBand traffic
  - 4            received via multiple virtual lanes and multiple queue pairs;
  - 5            identifying a first packet payload received via a first virtual lane and a first
  - 6            queue pair;
  - 7            determining whether the first payload can be stored in the memory
  - 8            structure without exceeding a portion of the memory structure allocated to the
  - 9            first virtual lane;
  - 10          determining whether the first payload can be stored in the memory
  - 11          structure without exceeding a portion of the memory structure allocated to the
  - 12          first queue pair;
  - 13          if storing the first payload in the memory structure would exceed said
  - 14          portion of the memory structure allocated to the first queue pair, determining
  - 15          whether the first queue pair is enabled to use a shared portion of the memory
  - 16          structure to store payloads of packets received via the first queue pair; and
  - 17          maintaining a second memory configured to store, for each of the multiple
  - 18          queue pairs that is active, one or more parameters associated with operation of
  - 19          said queue pair, wherein said parameters include:
    - 20            a maximum number of message credits advertisable by said queue
    - 21            pair;

22                   a maximum number of memory structure buffers dedicated to  
23                   storing payloads of packets received via said queue pair;  
24                   an indicator configured to indicate whether said queue pair is  
25                   enabled to use a set of shared memory structure buffers; and  
26                   a number of shared memory structure buffers in said set of shared  
27                   memory structure buffers, wherein said shared memory structure buffers  
28                   are available for use by said queue pair to store payloads of packets  
29                   received via said queue pair if:  
30                         said queue pair has used said maximum number of memory  
31                         structure buffers; and  
32                         said indicator indicates that said queue pair is enabled to  
33                         use said set of shared memory structure buffers; and  
34                         a maximum number of message credits advertisable by said queue  
35                         pair when said queue pair starts using said shared memory structure  
36                         buffers.

1                  2-10. (Cancelled)

1                  11. (Previously Presented) A computer readable medium storing  
2                  instructions that, when executed by a computer, cause the computer to perform a  
3                  method of flow controlling InfiniBand receive traffic, the method comprising:  
4                         maintaining a single memory structure for queuing InfiniBand traffic  
5                         received via multiple virtual lanes and multiple queue pairs;  
6                         identifying a first packet payload received via a first virtual lane and a first  
7                         queue pair;  
8                         determining whether the first payload can be stored in the memory  
9                         structure without exceeding a portion of the memory structure allocated to the  
10                         first virtual lane;

11           determining whether the first payload can be stored in the memory  
12       structure without exceeding a portion of the memory structure allocated to the  
13       first queue pair;

14           if storing the first payload in the memory structure would exceed said  
15       portion of the memory structure allocated to the first queue pair, determining  
16       whether the first queue pair is enabled to use a shared portion of the memory  
17       structure to store payloads of packets received via the first queue pair; and

18           maintaining a second memory configured to store, for each of the multiple  
19       queue pairs that is active, one or more parameters associated with operation of  
20       said queue pair, wherein said parameters include:

21                  a maximum number of message credits advertisable by said queue  
22       pair;

23                  a maximum number of memory structure buffers dedicated to  
24       storing payloads of packets received via said queue pair;

25                  an indicator configured to indicate whether said queue pair is  
26       enabled to use a set of shared memory structure buffers; and

27                  a number of shared memory structure buffers in said set of shared  
28       memory structure buffers, wherein said shared memory structure buffers  
29       are available for use by said queue pair to store payloads of packets  
30       received via said queue pair if:

31                  said queue pair has used said maximum number of memory  
32       structure buffers; and

33                  said indicator indicates that said queue pair is enabled to  
34       use said set of shared memory structure buffers; and

35                  a maximum number of message credits advertisable by said queue  
36       pair when said queue pair starts using said shared memory structure  
37       buffers.

1           12-29. (Cancelled)

1       30. (Previously Presented) A method of avoiding locking, in receive  
2       InfiniBand queues, the method comprising:

3           maintaining a single memory structure for reassembling InfiniBand traffic  
4       received via multiple virtual lanes and multiple queue pairs;

5           identifying a first packet payload received via a first queue pair that is  
6       idle, wherein the first queue pair is considered idle if no traffic from the first  
7       queue pair is stored in said single memory structure;

8           for each other queue pair for which traffic from said queue pair is stored in  
9       said single memory structure, determining whether sufficient space in the single  
10      memory structure is reserved for reassembling said traffic;

11          storing the first packet payload in said single memory structure only if  
12       sufficient space in the single memory structure is available for reassembling said  
13       traffic; and

14          maintaining a second memory configured to store, for each of the multiple  
15      queue pairs that is active, one or more parameters associated with operation of  
16      said queue pair, wherein said parameters include:

17            a maximum number of message credits advertisable by said queue  
18       pair;

19            a maximum number of memory structure buffers dedicated to  
20       storing payloads of packets received via said queue pair;

21            an indicator configured to indicate whether said queue pair is  
22       enabled to use a set of shared memory structure buffers; and

23            a number of shared memory structure buffers in said set of shared  
24       memory structure buffers, wherein said shared memory structure buffers  
25       are available for use by said queue pair to store payloads of packets  
26       received via said queue pair if:

27                   said queue pair has used said maximum number of memory  
28                   structure buffers; and  
29                   said indicator indicates that said queue pair is enabled to  
30                   use said set of shared memory structure buffers; and  
31                   a maximum number of message credits advertisable by said queue  
32                   pair when said queue pair starts using said shared memory structure  
33                   buffers.

1                 31. (Cancelled)

1                 32. (Previously Presented) An apparatus for flow controlling received  
2                 InfiniBand traffic, comprising:  
3                   a single memory structure configured to queue payloads of InfiniBand  
4                 traffic received via multiple virtual lanes and multiple queue pairs;  
5                   a resource manager configured to manage the memory structure;  
6                   a first module configured to facilitate the advertisement of virtual lane  
7                 credits;  
8                   a second module configured to facilitate the advertisement of queue pair  
9                 credits; and  
10                  a second memory configured to store, for each of the multiple queue pairs  
11                 that is active, one or more parameters associated with operation of said queue  
12                 pair, wherein said parameters include:  
13                   a maximum number of message credits advertisable by said queue  
14                 pair;  
15                   a maximum number of memory structure buffers dedicated to  
16                 storing payloads of packets received via said queue pair;  
17                   an indicator configured to indicate whether said queue pair is  
18                 enabled to use a set of shared memory structure buffers; and

19                   a number of shared memory structure buffers in said set of shared  
20                   memory structure buffers, wherein said shared memory structure buffers  
21                   are available for use by said queue pair to store payloads of packets  
22                   received via said queue pair if:

23                   said queue pair has used said maximum number of memory  
24                   structure buffers; and

25                   said indicator indicates that said queue pair is enabled to  
26                   use said set of shared memory structure buffers; and

27                   a maximum number of message credits advertisable by said queue  
28                   pair when said queue pair starts using said shared memory structure  
29                   buffers.

1                 33-55. (Cancelled)

1                 56. (New) A method of flow controlling InfiniBand receive traffic,  
2 comprising:

3                 maintaining a single memory structure for queuing InfiniBand traffic  
4 received via multiple virtual lanes and multiple queue pairs;

5                 maintaining a second memory configured to store, for each of the multiple  
6 queue pairs that is active, one or more parameters associated with operation of  
7 said queue pair, wherein said parameters include a maximum number of message  
8 credits advertisable by said queue pair;

9                 identifying a first packet payload received via a first virtual lane and a first  
10 queue pair;

11                 determining whether the first payload can be stored in the memory  
12 structure without exceeding a portion of the memory structure allocated to the  
13 first virtual lane;

14                 determining whether the first payload can be stored in the memory

15 structure without exceeding a portion of the memory structure allocated to the  
16 first queue pair; and

17 if storing the first payload in the memory structure would exceed said  
18 portion of the memory structure allocated to the first queue pair, determining  
19 whether the first queue pair is enabled to use a shared portion of the memory  
20 structure to store payloads of packets received via the first queue pair.

1 57. (New) The method of claim 56, wherein the second memory is  
2 further configured to store one or more additional parameters associated with  
3 operation of said queue pair, wherein said additional parameters include:

4 a maximum number of memory structure buffers dedicated to storing  
5 payloads of packets received via said queue pair;

6 an indicator configured to indicate whether said queue pair is enabled to  
7 use a set of shared memory structure buffers; and

8 a number of shared memory structure buffers in said set of shared memory  
9 structure buffers, wherein said shared memory structure buffers are available for  
10 use by said queue pair to store payloads of packets received via said queue pair if:

11 said queue pair has used said maximum number of memory  
12 structure buffers; and

13 said indicator indicates that said queue pair is enabled to use said  
14 set of shared memory structure buffers; and

15 a maximum number of message credits advertisable by said queue  
16 pair when said queue pair starts using said shared memory structure  
17 buffers.

1 58. (New) The method of claim 56, further comprising:

2 allocating a portion of the memory structure to each of the multiple virtual  
3 lanes; and

4               allocating a portion of the memory structure to each of the multiple queue  
5       pairs.

1               59.       (New) The method of claim 56, wherein the memory structure  
2       comprises a set of linked lists of memory structure buffers, including one linked  
3       list for each of the multiple queue pairs that are active.

1               60.       (New) The method of claim 56, further comprising:  
2               dropping the first payload if the first payload cannot be stored in the  
3       memory structure without exceeding the portion of the memory structure  
4       allocated to the first virtual lane.

1               61.       (New) The method of claim 56, further comprising:  
2               issuing a Retry, Not Ready, Negative Acknowledgement (RNR-NAK) if:  
3               the first payload cannot be stored in the memory structure without  
4       exceeding a portion of the memory structure allocated to the first queue  
5       pair; and  
6               the first queue pair is not enabled to use the shared portion of the  
7       memory structure.

1               62.       (New) The method of claim 56, further comprising:  
2               issuing a Retry, Not Ready, Negative Acknowledgement (RNR-NAK) if:  
3               the first payload cannot be stored in the memory structure without  
4       exceeding a portion of the memory structure allocated to the first queue  
5       pair;  
6               the first queue pair is enabled to use the shared portion of the  
7       memory structure; and  
8               the shared portion of the memory structure is full.

1       63. (New) The method of claim 56, further comprising:  
2           defining one or more dedicated thresholds in the portion of the memory  
3       structure allocated to the first queue pair; and

4           for each of said dedicated thresholds, identifying a number of message  
5       credits the queue pair may advertise when the amount of the memory structure  
6       used by the queue pair exceeds said dedicated threshold.

1       64. (New) The method of claim 56, further comprising:  
2           defining one or more shared thresholds in the shared portion of the  
3       memory structure; and  
4           for each of said shared thresholds, identifying a number of message credits  
5       the queue pair may advertise when the amount of the shared portion used by the  
6       multiple queue pairs exceeds said shared threshold.

1       65. (New) The method of claim 56, further comprising:  
2           receiving a request on a second queue pair to perform an RDMA (Remote  
3       Direct Memory Access) Read operation; and  
4           based on an amount of data expected to be received via the RDMA Read  
5       operation, reserving a sufficient number of buffers in the memory structure.

1       66. (New) The method of claim 56, further comprising:  
2           in the single memory structure, reassembling the queued InfiniBand traffic  
3       into outbound communications;  
4           receiving a payload on an idle queue pair, wherein a queue pair is idle if  
5       no traffic from the queue pair is stored in the single memory structure; and  
6           only queuing the payload in the single memory structure if sufficient space  
7       in the single memory structure is reserved for completing reassembly of outbound  
8       communications on each non-idle queue pair.

1           67. (New) A computer readable medium storing instructions that,  
2 when executed by a computer, cause the computer to perform a method of flow  
3 controlling InfiniBand receive traffic, the method comprising:

4                 maintaining a single memory structure for queuing InfiniBand traffic  
5 received via multiple virtual lanes and multiple queue pairs;

6                 maintaining a second memory configured to store, for each of the multiple  
7 queue pairs that is active, one or more parameters associated with operation of  
8 said queue pair, wherein said parameters include a maximum number of message  
9 credits advertisable by said queue pair;

10                 identifying a first packet payload received via a first virtual lane and a first  
11 queue pair;

12                 determining whether the first payload can be stored in the memory  
13 structure without exceeding a portion of the memory structure allocated to the  
14 first virtual lane;

15                 determining whether the first payload can be stored in the memory  
16 structure without exceeding a portion of the memory structure allocated to the  
17 first queue pair; and

18                 if storing the first payload in the memory structure would exceed said  
19 portion of the memory structure allocated to the first queue pair, determining  
20 whether the first queue pair is enabled to use a shared portion of the memory  
21 structure to store payloads of packets received via the first queue pair.

1           68. (New) The computer readable medium of claim 67, wherein the  
2 second memory is further configured to store one or more additional parameters  
3 associated with operation of said queue pair, wherein said additional parameters  
4 include:

5                 a maximum number of memory structure buffers dedicated to storing  
6 payloads of packets received via said queue pair;

7           an indicator configured to indicate whether said queue pair is enabled to  
8   use a set of shared memory structure buffers; and  
9           a number of shared memory structure buffers in said set of shared memory  
10   structure buffers, wherein said shared memory structure buffers are available for  
11   use by said queue pair to store payloads of packets received via said queue pair if:  
12                 said queue pair has used said maximum number of memory  
13                 structure buffers; and  
14                 said indicator indicates that said queue pair is enabled to use said  
15                 set of shared memory structure buffers; and  
16                 a maximum number of message credits advertisable by said queue pair  
17   when said queue pair starts using said shared memory structure buffers.

1           69.     (New) The computer readable medium of claim 67, wherein the  
2   method further comprises:  
3                 defining one or more dedicated thresholds in the portion of the memory  
4   structure allocated to the first queue pair; and  
5                 for each of said dedicated thresholds, identifying a number of message  
6   credits the queue pair may advertise when the amount of the memory structure  
7   used by the queue pair exceeds said dedicated threshold.

1           70.     (New) The computer readable medium of claim 67, wherein the  
2   method further comprises:  
3                 defining one or more shared thresholds in the shared portion of the  
4   memory structure; and  
5                 for each of said shared thresholds, identifying a number of message credits  
6   the queue pair may advertise when the amount of the shared portion used by the  
7   multiple queue pairs exceeds said shared threshold.

1           71. (New) The computer readable medium of claim 67, wherein the  
2 method further comprises issuing a Retry, Not Ready, Negative  
3 Acknowledgement (RNR-NAK) only if one of:  
4           (a) the first payload cannot be stored in the memory structure without  
5 exceeding a portion of the memory structure allocated to the first queue  
6 pair; and  
7                 the first queue pair is not enabled to use the shared portion of the  
8 memory structure; and  
9           (b) the first payload cannot be stored in the memory structure without  
10 exceeding a portion of the memory structure allocated to the first queue  
11 pair;  
12                 the first queue pair is enabled to use the shared portion of the  
13 memory structure; and  
14                 the shared portion of the memory structure is full.

1           72. (New) A method of avoiding locking in receive InfiniBand queues,  
2 the method comprising:  
3                 maintaining a single memory structure for reassembling InfiniBand traffic  
4 received via multiple virtual lanes and multiple queue pairs;  
5                 maintaining a second memory configured to store, for each of the multiple  
6 queue pairs that is active, one or more parameters associated with operation of  
7 said queue pair, wherein said parameters include a maximum number of message  
8 credits advertisable by said queue pair;  
9                 identifying a first packet payload received via a first queue pair that is  
10 idle, wherein the first queue pair is considered idle if no traffic from the first  
11 queue pair is stored in said single memory structure;  
12                 for each other queue pair for which traffic from said queue pair is stored in  
13 said single memory structure, determining whether sufficient space in the single

14 memory structure is reserved for reassembling said traffic; and  
15       storing the first packet payload in said single memory structure only if  
16 sufficient space in the single memory structure is available for reassembling said  
17 traffic.

1           73. (New) The method of claim 72, wherein the second memory is  
2 further configured to store one or more additional parameters associated with  
3 operation of said queue pair, wherein said additional parameters include:  
4           a maximum number of memory structure buffers dedicated to storing  
5 payloads of packets received via said queue pair;  
6           an indicator configured to indicate whether said queue pair is enabled to  
7 use a set of shared memory structure buffers; and  
8           a number of shared memory structure buffers in said set of shared memory  
9 structure buffers, wherein said shared memory structure buffers are available for  
10 use by said queue pair to store payloads of packets received via said queue pair if:  
11           said queue pair has used said maximum number of memory  
12 structure buffers; and  
13           said indicator indicates that said queue pair is enabled to use said  
14 set of shared memory structure buffers; and  
15           a maximum number of message credits advertisable by said queue  
16 pair when said queue pair starts using said shared memory structure  
17 buffers.

1           74. (Original) The method of claim 72, wherein said determining  
2 comprises, for each said other queue pair:  
3           identifying an amount of space in said single memory structure reserved  
4 for said other queue pair; and  
5           comparing said amount of reserved space to an amount of space expected

6 to be needed to complete reassembly of said traffic from said other queue pair.

1 75. (New) An apparatus for flow controlling received InfiniBand  
2 traffic, comprising:

3 a single memory structure configured to queue payloads of InfiniBand  
4 traffic received via multiple virtual lanes and multiple queue pairs;  
5 a second memory configured to store, for each of the multiple queue pairs  
6 that is active, one or more parameters associated with operation of said queue  
7 pair, wherein said parameters include a maximum number of message credits  
8 advertisable by said queue pair;

9 a resource manager configured to manage the memory structure;  
10 a first module configured to facilitate the advertisement of virtual lane  
11 credits;

12 a second module configured to facilitate the advertisement of queue pair  
13 credits.

1 76. (New) The apparatus of claim 75, wherein the second memory is  
2 further configured to store one or more additional parameters associated with  
3 operation of said queue pair, wherein said additional parameters include:

4 a maximum number of memory structure buffers dedicated to storing  
5 payloads of packets received via said queue pair;

6 an indicator configured to indicate whether said queue pair is enabled to  
7 use a set of shared memory structure buffers; and

8 a number of shared memory structure buffers in said set of shared memory  
9 structure buffers, wherein said shared memory structure buffers are available for  
10 use by said queue pair to store payloads of packets received via said queue pair if:

11 said queue pair has used said maximum number of memory  
12 structure buffers; and

13           said indicator indicates that said queue pair is enabled to use said  
14        set of shared memory structure buffers; and  
15           a maximum number of message credits advertisable by said queue  
16        pair when said queue pair starts using said shared memory structure  
17        buffers.

1           77.     (New) The apparatus of claim 75, wherein said single memory  
2        structure comprises multiple linked lists of memory structure buffers, including  
3        one linked list for each of the multiple queue pairs that is active.

1           78.     (New) The apparatus of claim 75, wherein said first module  
2        comprises an InfiniBand link core.

1           79.     (New) The apparatus of claim 75, wherein said second module  
2        comprises an acknowledgement generator configured to generate transport layer  
3        acknowledgements.

1           80.     (New) The apparatus of claim 75, further comprising a processor  
2        interface configured to facilitate the programming of operating parameters  
3        associated with the multiple virtual lanes and the multiple queue pairs.

1           81.     (New) The apparatus of claim 75, further comprising:  
2           a first memory configured to store one or more parameters associated with  
3        operation of a first virtual lane.

1           82.     (New) The apparatus of claim 81, wherein said one or more  
2        parameters include:  
3           a count of the number of memory structure buffers currently used to store

4 payloads of packets received via the first virtual lane; and  
5 a threshold, wherein a first packet is dropped if storing the payload of the  
6 first packet would cause said count to exceed said threshold.

1 83. (New) The apparatus of claim 75, wherein said one or more  
2 parameters further include:  
3 one or more dedicated thresholds, wherein each said dedicated threshold  
4 identifies a subset of said maximum number of memory structure buffers; and  
5 for each said dedicated threshold, a number of message credits  
6 advertisable by said queue pair when said queue pair uses said subset of said  
7 maximum number of memory structure buffers.

1 84. (New) The apparatus of claim 75, wherein said one or more  
2 parameters further include:  
3 one or more shared thresholds, wherein each said shared threshold  
4 identifies a subset of said number of shared memory structure buffers; and  
5 for each said shared threshold, a number of message credits advertisable  
6 by said queue pair when said queue pair uses said subset of said number of shared  
7 memory structure buffers.